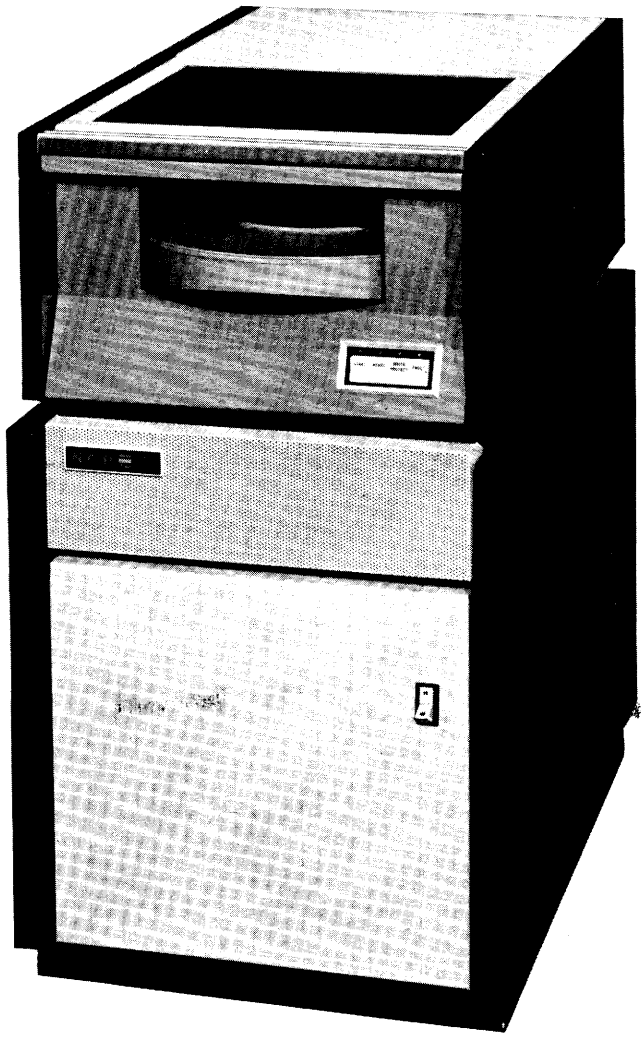
656—102 DISC UNIT



This publication contains the physical and functional descriptions of the NCR 656-102 Disc Unit. It is written with the assumption that the reader is familiar with magnetic storage media and has a knowledge of the basic disc storage and recording concepts. (Disc storage concepts are explained in this manual under GENERAL INFORMATION, Magnetic File Peripherals tab, "Basic Disc Concepts.")

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INTRODUCTION

GENERAL DESCRIPTION

The NCR 656-102 Disc Unit is a single-spindle unit housed in a low-profile cabinet. The 656 accommodates two recording discs; one optional fixed disc and one removable 956-1 disc pack. Each disc (fixed and removable) has a data storage capacity of 4.98 megabytes, providing a total data capacity of 9.96 megabytes per disc unit.

NOTE

> Both "cartridge" and "pack" are commonly used to describe a removable disc; to ensure uniform terminology, however, only "pack" is used in NCR Century publications.

The 656 Disc Unit uses the "master/slave" technique of operation; that is, a master unit (so designated because it contains the control unit) may control itself and one slave unit (a 656 Disc Unit not containing a controller). Both versions of the 656 Disc Unit (master and slave) are housed in identical low-profile cabinets and contain identical disc drives. The only difference between the units is the possession of the disc controller, which is located within the lower bay of the 656 master disc unit cabinet.

SYSTEM REQUIREMENTS

The NCR 656-102 Disc Unit transfers data at 312.5 KB (kilobytes) per second; it may be used as a freestanding peripheral on any common trunk that has a transfer rate greater than 312.5 KB. The 656 cannot be used as an integrated peripheral on any NCR Century system.

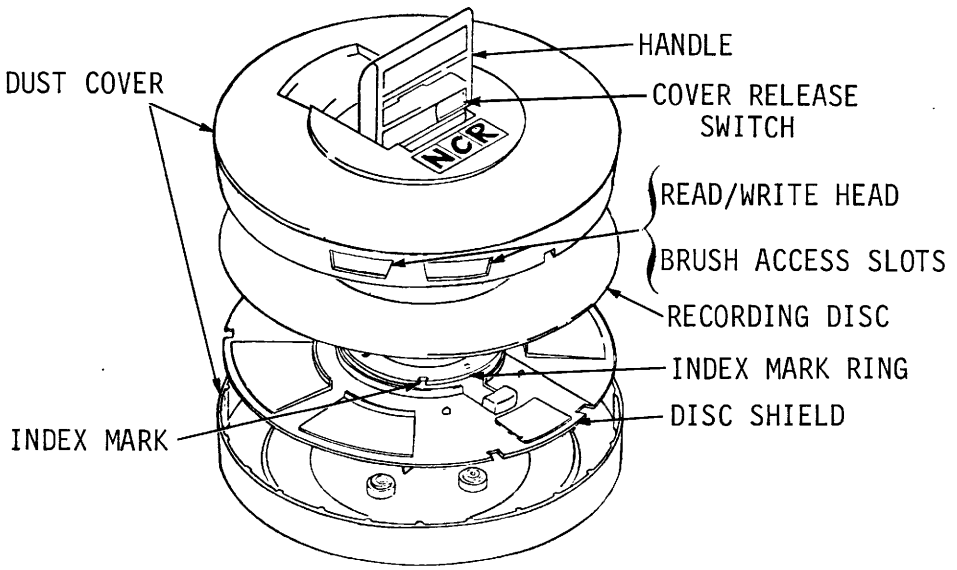
The 656 Disc Unit may be used as the system disc unit in either a single system-disc or dual system-disc operating system. When it is used as the system disc unit in either of these environments, the minimum hardware requirement is one 656-102 master Disc Unit containing both the fixed disc and removable disc pack. If, however, the 656 is to be used for file storage only (not as a system disc unit), the minimum hardware requirement is one 656-102 master Disc Unit containing the removable disc pack.

RECORDING MEDIA

REMOVABLE DISC PACK

The 956-1 disc pack is the removable data storage medium used with the NCR 656 Disc Unit. The disc pack consists of a dust cover, a disc shield, a recording disc, and an index mark ring.

REMOVABLE DISC PACK



The disc pack, when not in use, is enclosed in a 2-piece dust cover which provides protection against contamination and physical damage to the recording disc. The top section of the dust cover includes a recessable handle, which facilitates pack handling, and a cover release mechanism.

Before the pack can be used, the lower section of the dust cover must be removed to expose access slots for the read/write heads and cleaning brushes; these slots are located on the side of the upper section of the dust cover, and allow the read/write heads and cleaning brushes access to the recording disc. A disc shield, located below the recording disc, provides protection for the disc when the lower section of the dust cover is removed.

The recording disc is a metal platter covered with a magnetically sensitive metallic oxide coating on which data is recorded and stored. The data recording areas are located on the top and bottom surfaces of the disc platter.

The index mark ring is a small disc located between the recording disc and the disc shield. It contains a physical notch called an index mark that is used to indicate the physical start and end of the tracks located on the recording discs. (Tracks are described later in this publication under "Tracks.")

Physically, the disc pack is 2-1/2 inches high (with the handle recessed), 15 inches in diameter, and weighs 5-1/2 pounds. The recording density varies according to the position of the track on the recording surface; the outer track has a density of 1530 bits per inch, the inner track a density of 2220 bits per inch.

Disc Pack Organization

To facilitate the location of data on a disc pack, the recording area of each pack is divided into tracks, with each track divided into sectors.

- Tracks

  Each disc recording surface contains 406 circular recording tracks at a density of 200 tracks per inch (radially); the tracks are numbered consecutively from 0 to 405, beginning with the outside track. Of the 406 tracks, two (404 and 405) are used for maintenance purposes and six (per surface) are normally reserved as alternates for tracks that are defective. The physical start and end of the tracks are indicated by the index mark.

  Each track on a surface can be accessed by a single read/write head, which is positioned by a magnetically operated actuator. At any given time, two read/write heads (one for each surface of a recording disc) are in position to read data from or write data on corresponding tracks on opposite sides of the recording disc. These two tracks of available data are known as a cylinder; the pack contains 406 cylinders of data, for a total of 812 tracks per recording disc. (Data can be read or written only one track at a time; however, both read/write heads are in position on a disc and either may be chosen for use.)

- Sectors

  A track is divided into 12 sectors of equal length (9744 sectors per recording disc), with each sector containing one address area and one data area separated by a gap. The address areas and separation gaps contain the information used by the disc unit to locate specific data areas on a track; the data areas, which are 512 bytes in length, are used for the recording and storing of data.

- Disc Capacity

  The capacity of a disc pack is expressed in terms of the total number of available data bytes. Each disc pack is formatted into 9744 sectors, with each data area containing 512 data bytes, for a total of 4,988,928 data bytes per pack.

During the positioning operation, the disc drive logic circuitry requires a means of monitoring the response of the read/write heads to the positioning signals; this is accomplished with the use of a velocity transducer and a position transducer. The velocity transducer is a 2-piece unit consisting of a stationary tubular coil and a movable magnetic core. The tubular coil is located inside the stationary magnet of the motive assembly, and the movable core is located on the carriage. The movable core is free to move in and out of the tubular coil as the carriage moves. The travel of the movable core within the tubular coil causes signals to be generaged to the drive logic circuitry. These signals are interpreted as velocity signals by the circuitry.

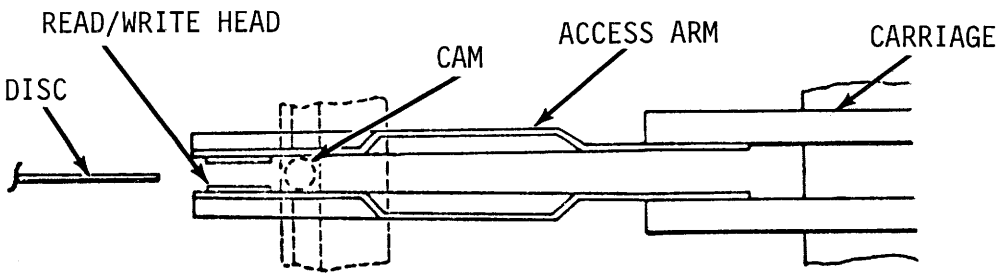
The position transducer is also a 2-piece unit consisting of two wire windings, one mounted on the carriage and the other mounted on the carriage track. As these windings pass each other, a signal generated by one is picked up by the other and interpreted as the crossing of a track; the drive logic circuitry keeps a count of the numbers of pulses received and uses this count to monitor the position of the read/write heads.

Read/Write Heads

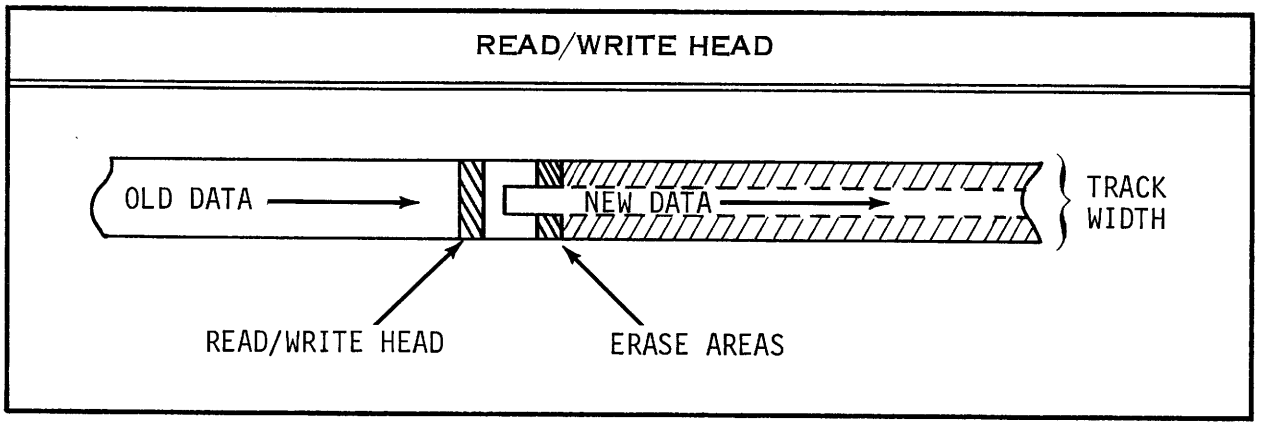
The NCR 656 Disc Unit uses one read/write head to access each recording surface of each disc. If both of the recording discs are installed (fixed and removable), the disc unit has four read/write heads; if the fixed disc is not installed, the disc unit has only two heads. In either case, each read/write head has a numeric designation used by the addressing scheme of the disc unit to access data.

The read/write heads are located on flexible access arms which are mounted on the carriage of the actuator assembly. As the heads are stored, they are retracted horizontally from the disc, and each pair of heads are separated vertically by a cam. When the heads are to be used, they are moved horizontally off the cam and toward the disc; the flexure of the access arms cause the heads to move vertically towards the recording surfaces. The design of the access arms and read/write heads are such that the cushion of air generated by the rotating disc holds the heads approximately 60 microinches from the recording surfaces.

READ/WRITE HEAD AND ACCESS ARM ASSEMBLY



A straddle/erase head is used to read and write data on the disc recording surface. This type of head writes the data across the entire width of the disc track with a signal strength sufficient to completely overlay previously written data. It then erases the portion of the signal that has been written on the outer edges of the track. This procedure ensures that minor head positioning variations between 656 Disc Units do not affect one unit's ability to read data from a disc pack written by another unit.



Access and Latency Times

The actuator moves the read/write heads to an adjacent track in 10 milliseconds. The maximum head movement time is 70 milliseconds, and the average head movement time is 35 milliseconds. The disc rotates at 2400 revolutions per minute, or one revolution every 25 milliseconds; the average latency time, which is the time required for the disc to make one-half a revolution, is 12.5 milliseconds. The average access time, determined by adding the average head movement time and the average latency time, is 47.5 milliseconds.

Drive Logic Circuitry

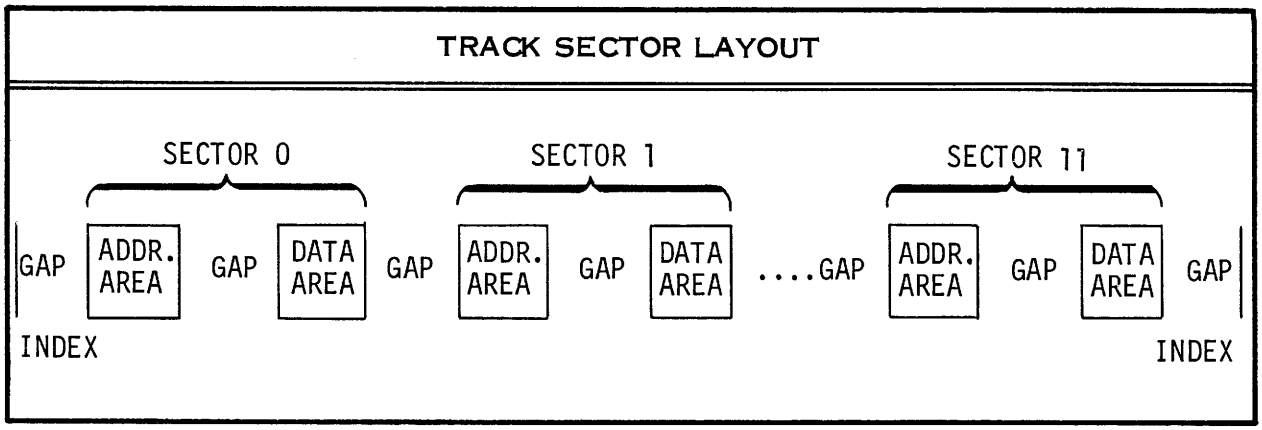
The disc drive logic circuitry is located in the upper bay of the disc unit cabinet. It serves as the interface between the disc controller and the disc drive. Several of the more important areas of the circuitry are (1) the subtracter and the difference counter, which are used in determining the number of cylinders between the present location of the read/write heads and the desired location during positioning, and (2) the head number decoder, which selects the read/write head that is to perform the function. The other logic circuits are used to indicate ready status, pack-on conditions, on-cylinder (read/write heads are on the desired cylinder), etc.

DISC CONTROLLER

The disc control unit, housed (along with its associated blowers and power supply) in the lower bay of a 656 master disc unit, interfaces NCR Century processors to NCR 656 Disc Units. The controller is capable of controlling both the master disc unit, in which it resides, and one slave disc unit (a 656 disc unit which does not contain a control unit). Electrical power is delivered to the disc controller when the master disc unit is powered up.

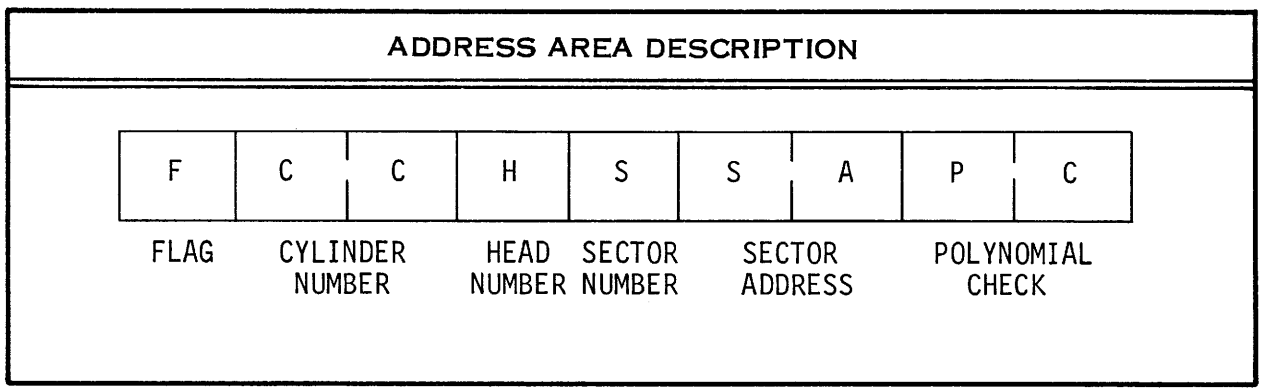
Track Formatting

Formatting of a recording disc is controlled by the Disc Initializer utility routine and the disc control unit. Starting at the index mark each track is divided into 12 sectors (numbered from 0 to 11), with each sector subdivided into an address area, a gap, and a data area. Certain control information is recorded in the gaps for use by the disc controller during the transmission of data to and from the disc.



- Address Area

  The address area in each sector is nine bytes in length. These nine bytes contain the address of the sector in which they are located. The address area also contains control information connected with the condition of the track in which the sector is located, and a check to verify the correctness of all the data in the address area.

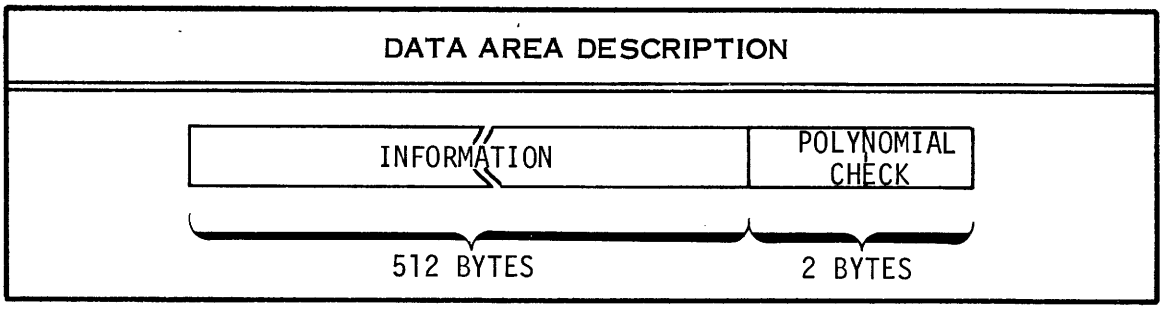


The information contained in the address area performs the following functions.

DESCRIPTION AND FUNCTIONS OF ADDRESS AREA BYTES		
BYTE DESCRIPTION	NUMBER OF BYTES	FUNCTION
FLAG	1	This byte indicates the condition of the track. Bit 8 - Used to detect a missing address marker; it is set to zero in the address area of the first sector on a track, and alternates in value for each consecutive sector. Bits 7 to 3 - Not used. Bit 2 - If zero, this flag indicates a good track; if one, it indicates a defective track. Bit 1 - If zero, this flag indicates a primary track; if one, it indicates an alternate track.
CYLINDER NUMBER	2	These bytes contain the number of the cylinder in which a track and sector are located; the number may vary from 0 to 405.
HEAD NUMBER	1	This byte contains the number of the read/write head (0 or 1) that accesses a particular track of the specified cylinder.
SECTOR NUMBER	1	This byte contains the number of the particular sector located within the specified track; the number may vary from 0 to 11.
SECTOR ADDRESS	2	These bytes contain a unique 14-bit consecutive sector address which may vary from 0 to 9743.
POLYNOMIAL CHECK	2	These bytes are used for data checking. Each time data is written on the disc, polynomial check characters are also written (in accordance with the bit pattern of that data). When the data is read, the bit pattern of the data is checked against the polynomial check characters; if the data bit pattern and the polynomial check characters compare equally, the data is correct.

- Data Area

The data area of each sector follows the address area of that sector, but is separated from the address area by a gap. The data area is 512 bytes in length, followed by a 2-byte polynomial check. The 2-byte polynomial check performs the same function as the polynomial check bytes of the address area.



Data areas that are not filled to the full 512-byte capacity contain an End-of-Data byte immediately following the last data byte; the remainder of the data area is filled with binary 1's. The End-of-Data byte (a special character consisting of binary 1's and missing disc timing pulses called clocks) and the binary 1's following it are used only by the disc controller; they are not transferred as data to or from the processor.

- Separation Gaps

The gaps separating sector from sector and address area from data area contain information necessary for the operation of the disc when reading or writing data. This information includes address marks, which indicate the beginning of the address area for each sector, and special bit configurations, which are used by the read/write heads in preparation for performing read and write functions within a sector.

Controller Functions

The disc controller performs the following functions during operation: (1) format and restore functions, (2) data functions, (3) address conversion, and (4) defective track handling.

- Format and Restore Functions

The format functions are used in conjunction with the Disc Initializer utility routine to write, check, or read the format of a disc. The Write format function is used to record the address area information of each sector, and to layout the data area and separation gaps. After a disc has been formatted, the Check Format function may be used to verify the recorded disc format with the format layout in processor memory. The Read Format function is used to transfer the contents of each sector address area (excluding the polynomial check bytes) to the processor memory.

The Restore function is used to reset all non-persistent errors within the disc drive and to move the read/write heads to cylinder zero. (The operation of the Format and Restore functions are explained later in this publication under "Function Code.")

- Data Functions

In addition to the Format and Restore functions, the controller also has three data functions; Write Data, Read Data, and Check Data. The Write and Read Data functions are used to write data on and read data from the data area in each sector. The Check Data function is used to verify information recorded in the data areas by comparing it to the data contained in the processor memory. (The operations of the Data functions are explained later in this publication under "Function Code.")

- Address Conversion

To access a data area on disc, the processor sends a 14-bit binary sector address to the disc control unit as a part of the peripheral address field (the peripheral address field is explained later in this publication under "Peripheral Selection"). This sector address is converted by the disc controller into a 4-byte address specifying cylinder, head, and sector numbers; these numbers are then used to position the read/write heads.

The cylinder number is equal to the quotient resulting from the division of the sector address by the number of sectors in a cylinder (24).

$$24 \overline{)\ \text{Sector Address}} \quad \text{Cylinder Number} + \text{Remainder A}$$

The head number is equal to the quotient resulting from the division of Remainder A, established during the cylinder number conversion, by the number of sectors per track (12).

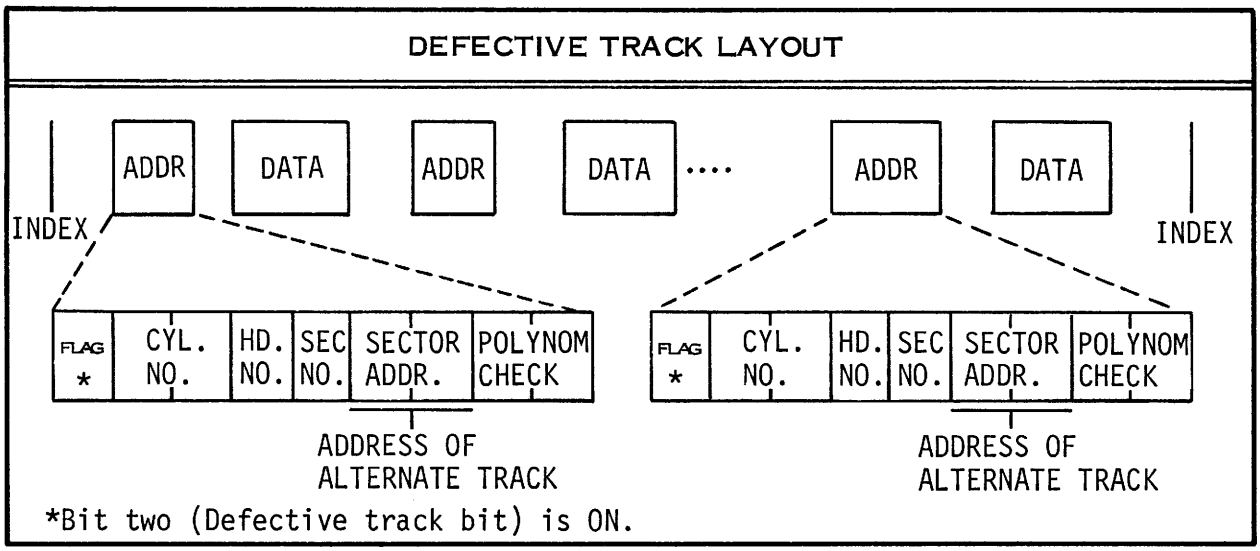
$$12 \overline{)\ \text{Remainder A}} \quad \text{Head Number} + \text{Remainder B}$$

The sector number is equal to Remainder B.

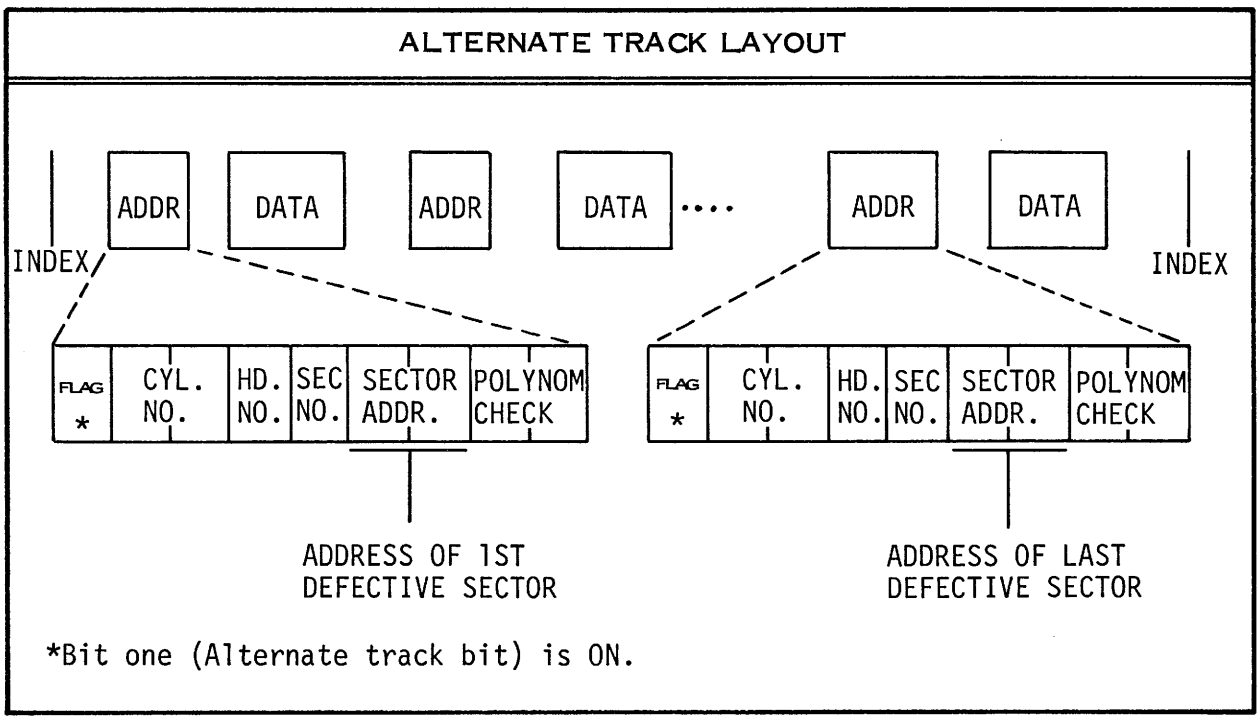
- Defective Track Handling

Alternate track assignment for defective tracks is handled by the Disc Initializer utility routine during the initialization of a recording disc. The initializer routine detects defective tracks, assigns alternate tracks, and uses format functions to layout both the defective and alternate tracks.

When a defective track is detected during the initialization of a disc, the defective track bit (located in the flag byte of each sector address area) is set ON; the sector address of the assigned alternate track is then recorded in the address areas of the defective track.



The initializer routine then lays out the format of the alternate track by setting the alternate track bit (located in the flag byte of each sector address area) ON and recording the sector address of the defective sector in the address area of the alternate sector. (One alternate track is assigned per defective track.)



Accessing of alternate tracks during program execution is handled entirely by the disc control unit and does not require program intervention. If an attempt is made to access a defective track, the disc unit reads the sector address of the alternate track from a sector of the defective track.

The information contained in this sector address is used only to locate the alternate track; the sector number (0-11) originally converted by the disc controller from the sector address is the same for both the defective and alternate sectors. When the read/write head is positioned over the alternate track, the controller reads until the correct sector is located. The controller then verifies that the disc unit has located the correct sector by comparing the address contained in the alternate sector with the alternate track number, the sector number, and the sector address sent by the processor; reading or writing of data then proceeds as normal.

FUNCTIONAL DESCRIPTION

GENERAL INFORMATION

All disc I/O operations are functionally divided into four parts: peripheral selection, track/sector accessing, data transfer, and peripheral termination. The processor begins I/O operation by executing an INOUT command to select the disc unit. After the unit is selected the processor returns to internal processing while the disc unit, under the direction of the controller, seeks the specified data area. When the desired data is located, the disc unit signals the disc controller and begins data transfer. Data transfer continues until the specified function is completed. Upon completion of data transfer, the disc controller informs I/O control of the conditions that caused the termination.

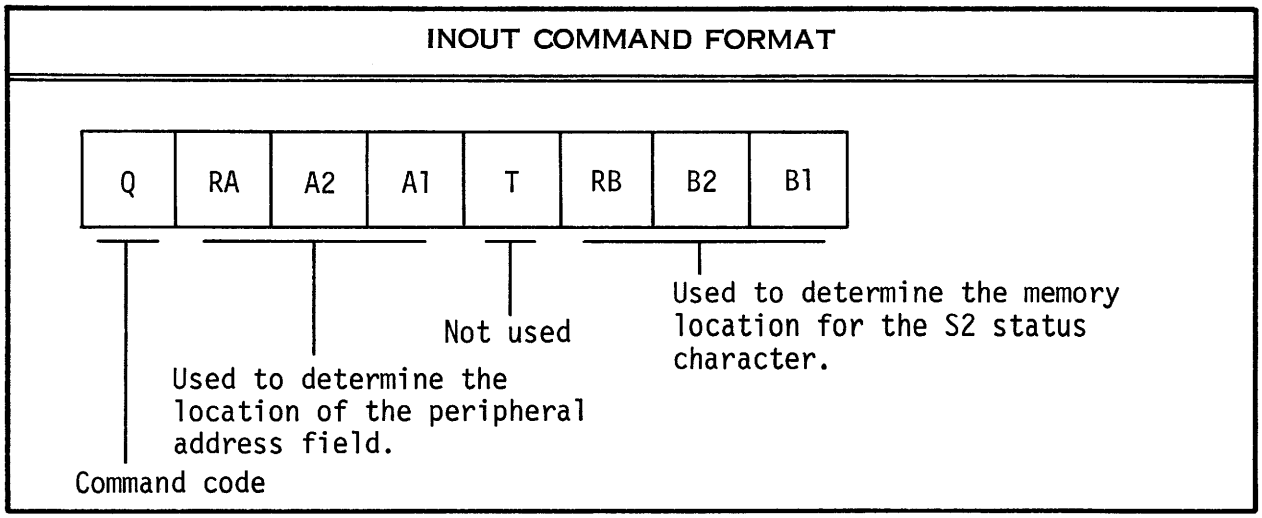
PERIPHERAL SELECTION

The selection of a peripheral during I/O operation involves (1) the INOUT command, which is used to initiate communication between the processor and its peripherals, (2) the peripheral address field, which contains the location of the peripheral and indicates the type of operation to be performed, and (3) the S2 status character, which is used to indicate the condition of the peripheral being selected.

INOUT Command

The INOUT command initiates all I/O operations between the processor and its peripherals. This command provides the processor with the location of the peripheral address field for the peripheral being selected and the memory location in which the S2 status character is stored following the selection attempt; the S2 status character indicates the result of the selection attempt. Whether the selection attempt is successful or not, the INOUT command terminates following the storing of the S2 status character, and the processor returns to normal internal processing.

The following illustration shows the format of the INOUT command.



Peripheral Address Field

The peripheral address field (PAF) contains the information necessary for the selection and operation of a peripheral. During the execution of the INOUT command, the processor locates the peripheral address field in memory and transmits a series of characters to indicate the location of the peripheral and the function to be performed. The peripheral address field for the NCR 656 Disc Unit is six bytes in length, with the following format.

PERIPHERAL ADDRESS FIELD FORMAT

BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6
0TTT 0PPP	0000 00UU	FFFF FFFF	00SS SSSS	SSSS SSSS	0000 NNNN

T = Trunk number
P = Position number
U = Unit number

F = Function code
S = Sector address
N = Number of additional sectors to be operated on by the designated function

- Trunk and Position Numbers

  The trunk and position numbers are used by the processor to locate the disc unit. The trunk number is a 3-bit binary number that designates the I/O trunk on which the disc unit is located; bits 7, 6, and 5 of byte one are used to store this number.

  The position number, also a 3-bit number, is used to designate the position of the disc unit on the specified trunk; bits 3, 2, and 1 of byte one are used to store this number.

- Unit Number

  The unit number specifies which of the four possible recording discs (two per master unit and two per slave unit) is to be used during the operation of the function specified by the function code; bits 2 and 1 of byte two are used to store this number. The unit numbers designate the specific recording discs as follows:

DISC UNIT NUMBERS	
DISC	BINARY UNIT NUMBER
FIXED MASTER DISC	00000000
REMOVABLE MASTER DISC	00000001
FIXED SLAVE DISC	00000010
REMOVABLE SLAVE DISC	00000011

- Function Code

The function code specifies the function to be performed by the disc unit. It is used by the disc controller to issue control instructions to either the master or slave unit that is to be associated with the I/O operation. Bits 8-1 of byte three contain the function code.

FUNCTION CODES		
NAME	BINARY CODE *	DESCRIPTION
READ DATA	X0000001	This function causes the disc unit to locate the specified sector and transfer data from that sector to the processor. Data transfer continues until (1) a processor terminate occurs, (2) an End-of-Data character is recognized, or (3) all the data in the last sector specified by the peripheral address field has been transferred. The polynomial check characters are used to verify the data being read.
WRITE DATA	X0000010	This function causes the disc unit to locate the specified sector and transfer data to it from the processor. Data transfer continues until a processor terminate occurs or until the data area in the last sector specified by the peripheral address field is filled. If the last sector is filled to capacity before a processor terminate is received, an End-of-Media status is sent to the processor; if the processor terminate occurs before the last specified sector is filled, the End-of-Data character is written in the current sector and each sector following it until the sector count (N) equals zero.

CONTINUED

* Bit 8 is reserved for software in these functions and may be either 1 or 0.

FUNCTION CODES [CONTINUED]		
NAME	BINARY CODE *	DESCRIPTION
WRITE DATA (CONT'D)	X0000010	If a sector is partially filled, the End-of-Data character is written followed by binary 1's to the end of the sector. The polynomial check characters are recorded on disc in accordance with the bit pattern of the data that is being written.
CHECK DATA	X0000011	This function verifies the data recorded on disc by comparing it byte by byte with data from the processor memory. If a processor terminate occurs after only one byte is compared, the comparison is ignored; however, the polynominal check for the section is verified.
READ FORMAT	X0000100	This function reads the first seven bytes of the address area and transfers them into contiguous locations in the processor memory. The transfer of the address areas starts with the sector following the index mark and continues until either a processor terminate occurs or the index mark is detected for the second time.
WRITE FORMAT	X0001000	This function is used during the initialization routine to format an entire track by writing from contiguous processor memory locations the information to be contained in its address areas; it also lays out the data field lengths and writes an End-of-Data character followed by binary zeroes in the data area of each sector. The function begins at the index mark and continues until either a processor terminate occurs or the index mark is detected for the second time. If any portion of the track remains unformatted, it is filled with binary 1's to the index.
CHECK FORMAT	X0001100	This function verifies the recorded format by comparing it byte by byte with the format layout in processor memory. The function always starts and terminates at the index mark. The data areas are verified with the polynomial check.
RESTORE	X0111100	This function resets all correctable errors within the disc drive, and moves the read/write heads to cylinder 0 if the selected disc drive is ready. Correctable errors include the following: 1. Multiple head selection. 2. Read and erase gate enabled at the same time.

CONTINUED

* Bit 8 is reserved for software in these functions and may be either 1 or 0.

FUNCTION CODES [CONTINUED]		
NAME	BINARY CODE *	DESCRIPTION
RESTORE (CONT'D)	X0111100	3. Read and write gate enabled at the same time. 4. Erase current and no write gate. 5. Write current and no erase gate. 6. Read, write, or erase is selected without an on-cylinder signal being sent. 7. Low voltage present. 8. Seek error.

* Bit 8 is reserved for software in this function and may be either 1 or 0.

- Sector Address

  The sector address, which may vary from 0 to 9743, is used by the disc controller to position the read/write heads and to locate the desired sector. The disc controller converts the 14-bit sector address into four bytes which specify the cylinder, head, and sector number of the disc being accessed. Bytes four and five of the peripheral address field contain the 14-bit sector address.

- Number of Additional Sectors

  The N byte of the peripheral address field contains the number of additional sectors to be operated on by the designated function. This number may vary from 0 (indicating that no additional sectors are to be operated on) to 11 (indicating that all sectors on the track are to be operated on).

S2 Status Characters

The NCR 656 Disc Unit is selected for I/O operation when the location to which it is assigned matches the location indicated by the peripheral address field. If for some reason the disc unit cannot respond to the selection attempt within a specified length of time, the processor terminates the INOUT command and stores the appropriate S2 status character in the specified memory location; the system software then takes whatever corrective action is necessary. If the trunk is not busy and the disc unit is operational, the command-initiated status is stored; the processor then terminates the INOUT command and places the disc unit under the supervision of the processor's I/O control.

The following S2 status characters are recognized by the system software.

S2 STATUS CHARACTERS		
HEX CODE	STATUS	INDICATION
02	INOPERATIVE	This code indicates that a condition exists which leaves the disc unit inoperative (power to the controller or disc drive logic not on, etc.).
80	BUSY	This code indicates that either the master or slave unit is currently busy with data transfer.
82	STANDBY	This code indicates that the operator has placed the disc unit in the standby state.
A3	CONTROL LINE PARITY ERROR	This code indicates that a parity error is detected by the controller.
40	COMMAND INITIATED	This code indicates that the selection process was successfully completed.

TRACK AND SECTOR ACCESSING

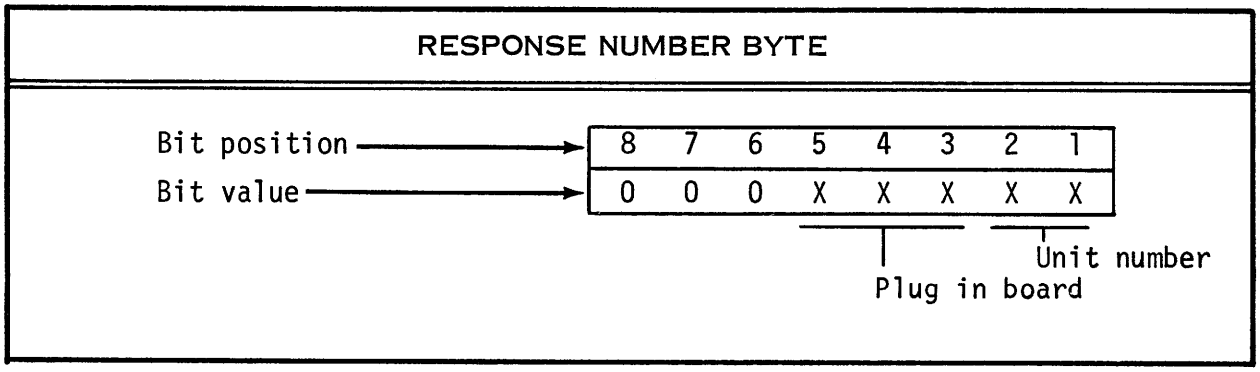
Following the storage of the command-initiated status, the disc controller converts the sector address obtained from the peripheral address field into cylinder, head, and sector numbers. The disc unit then uses the cylinder and head numbers to locate the correct track on the disc by computing the difference between the old and new cylinder numbers and storing it in the difference counter, and then selecting the specified read/write head. As the heads are moved across the disc the difference counter is decremented each time a track is crossed; when the counter is decremented to zero, the head is located over the correct track and begins looking for the designated sector. The correct sector is located when the sector address and sector number received from the controller is equal to those on the disc.

DATA TRANSFER

After the specified sector is located, the disc controller transmits a response number to I/O control indicating that it is ready to send or receive data. I/O control then computes the address of a control word from the response number, accesses the control word, and begins to either send or receive data from the disc unit. Data transfer between the disc controller and the processor takes place a byte at a time; transfer between the controller and disc unit, bit serially.

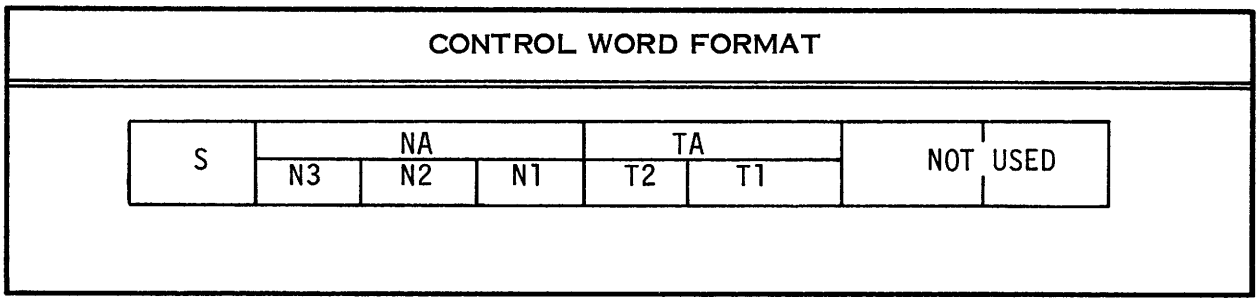
Response Number

With every request for service, the disc controller transmits a unit response number which specifies the control word to be used for each disc during I/O operations. The response number is one byte in length, with only the least significant five bits of the byte being used. Of the five bits, the three most significant bits are determined by a plug in board in the disc controller; the two least significant bits designate the recording disc (the fixed or removable disc of either the master or slave disc unit).



Control Word

After I/O control receives the response number from the disc unit, it locates the control word associated with that number. The control word used with the NCR 656 Disc Unit is eight bytes in length; it is used by I/O control to locate data in processor memory, to determine when to terminate the operation, and to store the status character indicating how the operation terminated.



S - Storage location for the status character (S3 or S4) which indicates the result of the I/O operation.

NA - Address of the next byte in memory from which data is to be sent to the disc unit, or into which data from the disc unit is to be stored.

TA - Terminating address, representing the last address plus one, of the processor memory to be accessed. After each character is accessed by I/O control, the NA address is incremented by one and compared to the TA address. When NA equals TA, the processor terminates the I/O operation. The NA/TA arrangement allows a maximum record size of 65,536 bytes.

PERIPHERAL TERMINATION

When data transfer is completed (or earlier if an error is detected), a status character is stored in the control word to indicate the condition of the I/O operation. Once the character is stored, the operating software investigates the status character and takes whatever action is necessary. The status character may be either an S3 or S4 status character, depending on the terminating condition of the I/O operation.

S3 Status Characters

Upon completion of the I/O operation, the disc unit sends an S3 status character to the processor, which is then stored in the disc unit's associated control word. The S3 status characters and the conditions they indicate are listed in the following table.

S3 STATUS CHARACTERS

HEX CODE	CONDITION	INDICATION
00	OPERATION COMPLETE	This code indicates the completion of a successful operation.
03	ILLEGAL FUNCTION CODE	This code indicates that a function code other than one of the seven specified function codes was received.
04	ILLEGAL FLAG	This code indicates that both the defective and alternate track bits are on in a sector address area, or that the alternate track bit was off in an alternate track address area when the alternate track was being accessed.

CONTINUED

S3 STATUS CHARACTERS [CONTINUED]		
HEX CODE	CONDITION	INDICATION
10	SYSTEM OVERLOAD	This code indicates a system overload due to a data transfer rate error.
12	MISSING FIELD	This code indicates that either two consecutive address markers (bit 8 in the flag byte of the address area) had the same state in consecutive sectors, or that a data field was not detected between two address fields.
18	SEEK MALFUNCTION	This code indicates any of the following conditions: (1) the read/write heads tried to move more than 406 cylinders, (2) a seek was not completed in the allotted time, or (3) a sector address greater than 9744 sectors was received from the processor.
20	TIMING ERROR	This code indicates that a clock was not detected every 1.5 bit times.
23	FORMAT READ ERROR	This code indicates either than an address area failed the polynomial check, or that a timing error occurred in the address area during a Read Format function.
26	SECTOR NOT FOUND	This code indicates that the desired sector was not found after one full revolution of the disc. This could be caused by an erroneous seek, bad formatting, or a read error.
27	DATA COMPARE ERROR	This code indicates that information read from the disc during a Check function did not agree, bit by bit, with the information contained in the processor memory.
28	END OF MEDIA	This code indicates any of the following conditions: (1) a multiple sector function was not completed when the index mark was detected, (2) NA was not equal to TA when the index mark was detected during a format function, (3) a Read or Write function was not completed when the

CONTINUED

S3 STATUS CHARACTERS [CONTINUED]		
HEX CODE	CONDITION	INDICATION
28	END OF MEDIA (CONT'D)	index mark was detected, or (4) more bytes were specified during a Write function than sector capacity allows (512 bytes/sector).
2E	DATA FAILED POLYNOMIAL CHECK	This code indicates that data within a sector failed the polynomial check; no additional sectors are read.
2F	ADDRESS AREA FAILED POLYNOMINAL CHECK (NON-DEFECTIVE TRACK ONLY)	This code indicates that the address field read during a Format Check function, failed the polynomial check. It also indicates that an address area failed the polynomial check during the search phase for a designated sector when using the Data functions.
30	DRIVE MALFUNCTION	This code indicates that the disc drive went out of ready while selected.
50	DATA DESTROYING ERRORS (FAULT)	This code indicates that a data destroying error has occurred. The disc controller inhibits any other function from being executed until a Restore function is issued. Upon receipt of a Restore function, the disc controller attempts to clear the fault within the disc drive. If any other function is issued prior to the Restore function, this status character will be stored again.
70	OPERATOR ERROR	This code indicates that the disc drive was write-protected during a write attempt.
81	TRANSMISSION ERROR	This code indicates that a parity error was discovered by the disc controller in incoming data.

S4 Status Characters

I/O control generates and stores an S4 status character in the selected peripheral control word if a latent ME, PE, or transmission error is detected during the operation of that peripheral. The disc controller then deselects the disc unit and terminates the function in progress; no terminating S3 status character is sent to I/O control. If an error occurs during the transmission of an

S3 status character, I/O control ignores the S3 status, generates an appropriate S4 status character, and stores it in place of the S3 status character.

S4 STATUS CHARACTERS		
HEX CODE	CONDITION	INDICATION
81	TRANSMISSION ERROR	This code indicates that a parity error has been detected by the processor's I/O control logic.
84	LATENT ME	This code indicates that a memory error has been detected by the processor's I/O control logic.
88	LATENT PE	This code indicates that a program error has been detected by the processor's I/O control logic.

SPECIFICATIONS

PHYSICAL

The following tables contain the physical specifications for both the NCR 656-102 Disc Unit and its recording media.

DISC UNIT PHYSICAL SPECIFICATIONS

CHARACTERISTIC	MASTER UNIT	SLAVE UNIT
DIMENSIONS		
Height	34 inches	34 inches
Width	17-1/4 inches	17-1/4 inches
Depth	29-3/4 inches	29-3/4 inches
ACCESS CLEARANCE		
Front	36 inches	36 inches
Side	20 inches	20 inches
Rear	36 inches	36 inches
WEIGHT	300 lbs.	275 lbs.
HEAT DISSAPATION	3460 btu/hr	2850 btu/hr
AC POWER REQUIREMENTS		
Voltage	120 vac ± 10% single phase 3 wire	120 vac ± 10% single phase 3 wire
Frequency	50 or 60 hz (± 1 hz)	50 or 60 hz (± 1 hz)
Current	8.5 amps	7.0 amps
KVA	1.020 kva	0.840 kva

RECORDING MEDIA SPECIFICATIONS

CHARACTERISTIC	956-1 DISC PACK	FIXED RECORDING DISC
DIMENSIONS		
Disc Pack Diameter	15 inches	Does not apply.
Disc Pack Height	2-1/2 inches	Does not apply.
Disc Diameter	14 inches	14 inches
Disc Thickness	0.05 inch	0.05 inch
WEIGHT	5-1/2 lbs.	Does not apply.
COMPOSITION OF RECORDING SURFACE	Ferrous oxide	Ferrous oxide

CONTINUED

RECORDING MEDIA SPECIFICATIONS [CONTINUED]		
CHARACTERISTIC	956-1 DISC PACK	FIXED RECORDING DISC
NUMBER OF RECORDING DISCS	1	1
NUMBER OF RECORDING SURFACES	2	2
NUMBER OF TRACKS PER SURFACE	406	406
RECORDING DENSITY		
Inner Track Outer Track	2220 bits/inch 1530 bits/inch	2220 bits/inch 1530 bits/inch

ENVIRONMENTAL

The following table contains a list of the environmental operating limits for the NCR 656-102 Disc Unit and its recording media. The 956-1 disc pack should be in this environment two hours prior to its use.

OPERATING LIMITS	
TEMPERATURE	68°F to 78°F Dry Bulb
HUMIDITY	40% to 60% Relative
ALTITUDE	7000 Feet Maximum